National Institute of Environmental Health Sciences

Meso-urban meteorological and photochemical modeling of heat island mitigation

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Abstract:

A fine-resolution, meso-urban meteorological model was updated and applied, using new data and techniques in this study, in driving fine-resolution photochemical simulations to evaluate the air-quality impacts of urban heat island mitigation. The drag-force-based formulation of the model improves the simulation of fine-resolution meteorological and air-pollutant concentration fields in the urban canopy layer. Compared to the meso scale, the meso-urban modeling of heat island mitigation produces larger localized impacts on meteorology and ozone air quality and captures phenomena of interest that are typically not detectable at the coarser scale. These include, for example, cool islands, heat islands, flow convergence associated with heat island circulation, flow divergence at the leading edge of urban areas, and vertical variation in turbulent kinetic energy budget components within the canopy layer in response to vertical changes in densities of buildings and vegetation. They also include fine-resolution features in the simulated ozone concentration field and its response to surface modifications. Model results show that heat island mitigation is effective in reducing local ozone concentrations. This paper presents results from Sacramento, California, as an example using increased urban albedo as the control mechanism. For the region, episodic conditions, and surface modification scenarios examined in this paper, air temperature is decreased by up to 3 °C. Changes in ozone consist overwhelmingly of decreases but can also involve increases with the latter being confined to small areas and short time intervals. While larger reductions in ozone are detected, decreases of up to 5-10 ppb are more representative and the daily maximum 8-h average can be decreased by up to 13%.

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Resource Description

Exposure :

weather or climate related pathway by which climate change affects health

Temperature

Temperature: Extreme Heat, Fluctuations

Geographic Feature:

resource focuses on specific type of geography

Urban

Geographic Location: ☑

resource focuses on specific location

United States

Health Impact: ☑

specification of health effect or disease related to climate change exposure

Health Outcome Unspecified

Mitigation/Adaptation: ☑

mitigation or adaptation strategy is a focus of resource

Mitigation

Model/Methodology: ☑

type of model used or methodology development is a focus of resource

Computing System, Methodology

Resource Type: ☑

format or standard characteristic of resource

Research Article

Timescale: ☑

time period studied

Time Scale Unspecified